5/8/2024

Tedra Cannella
Cannella Snyder
315 W. Ponce de Leon Ave, Suite 885
Decatur, GA 30030

Re: FR26 Amended Report

File: **Bryson v. Rough Country**
Quest File No: 10519

Dear Ms. Cannella,

This document serves as an amendment to the FR26 report previously submitted on October 12, 2023, regarding the case of Bryson v. Rough Country. The purpose of this amendment is to address an unforeseen technical issue that resulted in the loss of the original simulation file, which was used in some of my initial findings.

My intention was to produce the entire simulation, including raw data and all reports but because data was lost, we ran an amended simulation as spelled out below.

As this report discusses, my conclusions have not changed. The amended simulation results in a nearly identical amount of crush as was found in the initial simulation. Analysis of both simulations result in the same conclusion:

Calculations and simulations of the accident with the F250 at factory height produced a collision that reduced the Escape's crush and resulted in damage which would not have penetrated to the rear seat such that the rear occupant compartment would not have been compromised.

Background

The subject crash involved a lifted Ford F250, which rear-ended a Ford Escape at 51 mph. The F250 overrode key structural components of the Escape by engaging with the hatch, rather than the bumper. As discussed in the previously submitted FR26 report, a simulation was run to study the effect of bumper height on the dynamics of the crash. Since this simulation had been corrupted and the precise parameters can no longer be extracted, a simulation was run again and is discussed in this report.

Work Performed

The initial simulation and the rerun simulation were generated using the same methodology, by using the software Human Vehicle Environment (HVE) by Engineering Dynamics Company (EDC), using Simulation Model Non-Linear (SIMON).

Our attempt to precisely reproduce the simulation discussed in my October 12, 2023 report were unsuccessful because data used in that simulation was lost. Therefore, we ran an amended simulation, which was performed consistent with my deposition testimony.

Initial Simulation Comparison to Rerun Simulation

In the amended simulation, instead of using Neptune data for the stiffness coefficients, the properties for the F250 came directly from the Vehiclemetrics database. I testified in my deposition that I would use this data if it was available in the software suite, and because we have now located it after the deposition, I used it in the amended simulation. Essentially, my intent was to use any default data from HVE in my simulation, if possible, and I am doing this to this day. To be clear, we originally, and still are using HVE's Ford Escape properties.

In my deposition, stated the offset was one foot to the driver's side on the Escape, which has been used in the simulation rerun. My conclusion is that the lateral offset between the vehicles was 1 foot, as evidenced on the accident Escape's rear hatch and Ford F250's front.

The amended simulation includes no braking on either vehicle, even though the black box data indicates the F250 driver applied the brakes shortly before impact. Applying braking would tend to reduce crush on the Escape. Omitting braking makes my estimate of the increased crush the lift causes more conservative.

The opposing expert indicates that the tire sizes used in the simulation should have been larger. I updated the simulation accordingly.

Vehicles

HVE contains a default vehicle database from EDC. Vehicle databases, such as Vehiclemetrics, may also be imported to HVE. The vehicles were both weighed at the inspection on 2/22/2022 by a representative of Quest Engineering & Failure Analysis.

The vehicle used for the subject F250 was a 2008-2016 year range Ford F250 Super Duty XL 4x4 from the Vehiclemetrics database. This vehicle was the regular cab body style, while the subject truck was a crew cab. The regular cab geometry was replaced with a scan-based crew cab geometry. The scan was based off an exemplar stock 2015 F250 Super Duty 4x4 Crew Cab (VIN: 1FT7W2BT2FEC86347). The geometry was generated by an EDC Modeling Partner, Baker Sneddon Consulting. The exemplar F250 placard had slightly smaller wheels than the subject F250 placard, with a total difference in wheel radius of 0.45 inches, however the simulation wheels were modified to match the original accident vehicle tire diameters. The weight was adjusted to the measured weight of the accident truck plus the weights of the occupant and cargo, totaling 8485 pounds (*Appendix A*). The dimensions were verified

using Expert AutoStats. The tires used on the F250 were P275/60R20 (as this was the closest option in the database to the stock subject truck), which were about 0.55 inches smaller in radius. The radius was then adjusted to the stock accident wheel radius of 17.05 inches. The bumper height of the stock F250 of 29 inches in the simulation was verified through measurements of the exemplar truck (Figure 1), in addition to the measurements of the exemplar F250 used in the crash test that was performed by Exponent (*Figure 2*). Other properties of the F250 used in the simulation rerun were defaults.

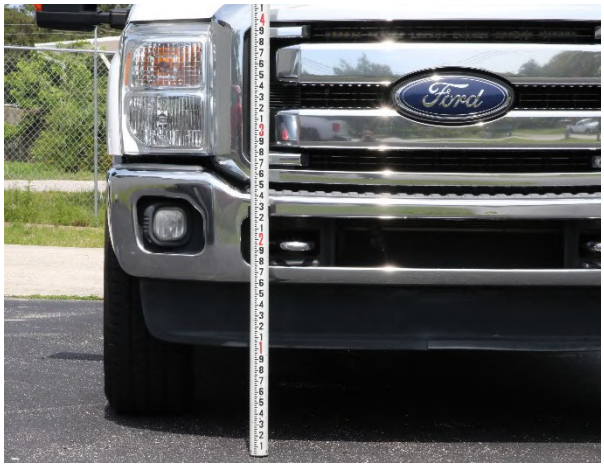

Figure 1: F250 Exemplar (Quest)

Figure 2: F250 Exemplar (Exponent)

The vehicle used for the subject Escape was a 2001-2011 year range Ford Escape from the EDC database. The weight was adjusted to the measured weight of the accident vehicle plus the weights of the occupants and cargo, totaling 3743 pounds (*Appendix A*). Other properties of the Escape used in the simulation rerun were defaults.

Positions

In the simulation rerun, the Escape was placed at 0 mph in an arbitrary location. The front of the F250 was placed just behind the rear of the Escape with a lateral offset of 12 inches to the left of the Escape. The speed of the F250 was 51 mph.

Simulation

Once the parameters discussed above had been set, the simulation was run. The target for the simulation was reaching a longitudinal delta-V on the F250 of 17.92 mph that was recorded in the black box of the subject F250. This was achieved by varying the relaxation length, which resulted to be 0.099.

Observations and Results

F250

The HVE software uses a consistent methodology to measure crush, which it applied to the F-250 and the Ford Escape in both simulated crashes. The difference in bumper crush between the two simulation

runs was on average less than 0.1 feet (*Figure 3*). The delta-V resulted to be 17.9 mph, consistent with the black box data.

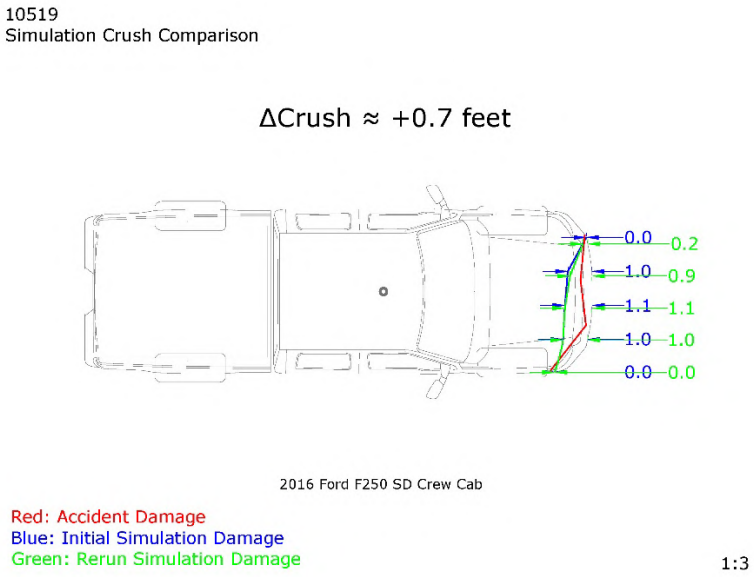

Figure 3: F250 Crush Comparison

Escape

The difference in bumper-level crush between the two simulation runs was on average less than 0.1 feet (*Figure 4*). The delta-V on the Escape resulted to be 40.2 mph, 0.4 mph more than in the initial simulation.

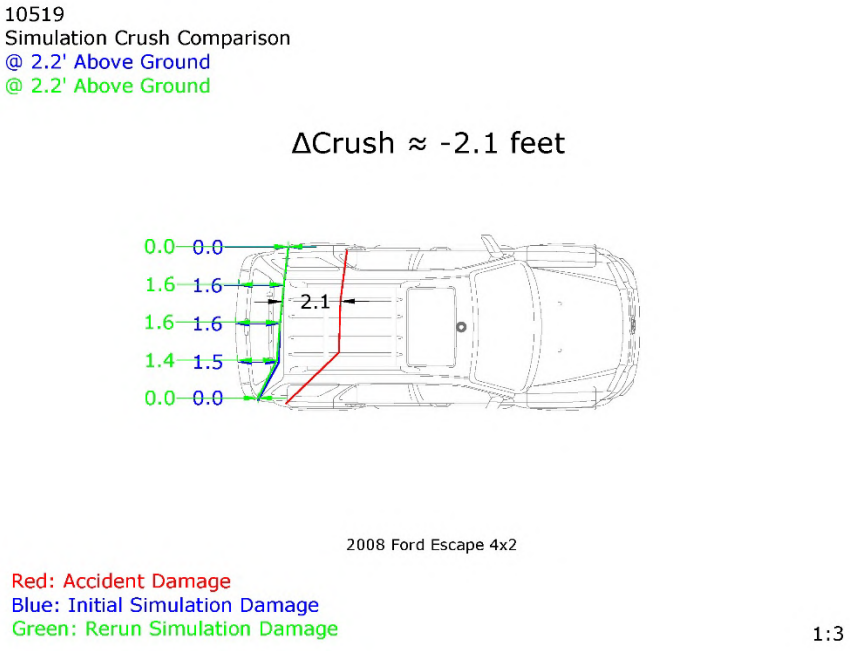

Figure 4: Escape Crush Comparison

Opinions

The simulation rerun results were very similar in results such that none of my opinions need to be amended. I am providing a full electronic copy of my simulation run such that defense experts can verify results, if they want to do so. The methodology discussed in my deposition is the same methodology I have used here, with the exceptions outlined above, which make my work simply more accurate to the subject accident. My conclusion also remains the same. None of my conclusions, which are detailed on pages 10-11 in my October 12, 2023 Report, have changed. In my deposition, I detailed these opinions and my work which is essentially unchanged. I have now also provided a working copy of the simulation to help support my opinions.

The reports generated by HVE are attached (*Appendix B*).

I reserve the right to continue to supplement my opinions as discovery is ongoing.

Sincerely,

QUEST ENGINEERING & FAILURE ANALYSIS, INC.

G. Bryant Buchner, P.E.
Chief Engineer

GBB/MAP

F-250 Weight Calculation

$Weight_{250} := 8040\ lbf$

$Driver_{250} := 170\ lbf$

$Chainsaw := 15.6\ lbf$

$Storagebox_{250} := 159\ lbf$

$Tools\_est := 100\ lbf$

$Total_{250} := Weight_{250} + Driver_{250} + Chainsaw + Storagebox_{250} + Tools\_est$

$Total_{250} = \left(8.485 \cdot 10^{3}\right)\ lbf$

Ford Escape Weight Calculation

$Weight_{Escape} := 3410\ lbf$

$Occupants_{Escape} := 318\ lbf$

$Car\_Seat := 15.2\ lbf$

$Total_{Escape} := Weight_{Escape} + Occupants_{Escape} + Car\_Seat$

$Total_{Escape} = \left(3.743 \cdot 10^{3}\right)\ lbf$

$Total_{total} := Total_{Escape} + Total_{250} = \left(12.228 \cdot 10^{3}\right)\ lbf$

Untitled Wed 05/08/24 17:09:23
Accident History-SIMON, Simulation HVE 2021 Version 17.00
Licensed User: Quest Engineering & Failure Analysis PAGE 1

----- ACCIDENT HISTORY -----

	time (sec)	X (ft)	Y (ft)	Heading (deg)	Vtot (mph)	U (mph)	V (mph)	Yaw Vel (deg/sec)
-Start of Simulation-								
Ford Escape 4-Dr	0.0000	0.1	-0.0	0.0	0.0	0.0	0.0	0.0
Ford F-250 Super Duty		-17.8	-1.0	0.0	51.0	51.0	0.0	0.0
----- At Impact -----								
Ford Escape 4-Dr	0.0190	0.1	-0.0	0.0	0.2	0.0	-0.0	0.0
Ford F-250 Super Duty		-16.4	-1.0	-0.0	51.0	51.0	0.0	-0.0
--- At Separation ---								
Ford Escape 4-Dr	0.1450	4.8	0.2	0.3	39.7	39.6	1.4	-2.2
Ford F-250 Super Duty		-9.1	-1.1	1.5	33.1	33.1	-1.3	13.5
--- At Final/Rest ---								
Ford Escape 4-Dr	1.0010	53.8	-0.8	-2.8	38.7	38.7	-0.4	0.9
Ford F-250 Super Duty	1.0010	32.0	-0.0	2.2	32.5	32.5	-0.0	-0.0

--------- VEHICLE COLLISION KINETICS ----------

Vehicle Name: Ford Escape 4-Dr

Imp No	Collision With	Collision Pulse --- Start (sec)	End (sec)	Length (sec)	Peak ---- Accel (g)	Force (lb)	Delta-V (mph)	PDOF (deg)
1	Ford F-250 Super Dut	0.0190	0.1450	0.1260	44.58	169494	40.2	-177.8

Vehicle Name: Ford F-250 Super Duty

Imp No	Collision With	Collision Pulse --- Start (sec)	End (sec)	Length (sec)	Peak ---- Accel (g)	Force (lb)	Delta-V (mph)	PDOF (deg)
1	Ford Escape 4-Dr	0.0190	0.1450	0.1260	19.41	169496	17.9	2.2

---------- VEHICLE DAMAGE PROFILES ----------

Vehicle Name: Ford Escape 4-Dr

Imp No	Collision With	CDC SAEJ224b	Damage Width (in)	Width Offset (in)	Damage Height (in)	Height Offset (in)	Max Crush (in)
1	Ford F-250 Super Duty	06BDAW3	65.2	-2.0	42.3	-8.6	19.2

Vehicle Name: Ford F-250 Super Duty

Imp No	Collision With	CDC SAEJ224b	Damage Width (in)	Width Offset (in)	Damage Height (in)	Height Offset (in)	Max Crush (in)
1	Ford Escape 4-Dr	12FDEW2	62.1	8.0	40.6	-3.1	12.6

--------- VEHICLE CRUSH DEPTH TABLES ----------

Vehicle Name: Ford Escape 4-Dr

Imp No	Collision With	Elev/Dist (in)	-- Crush Depths (Excl. Free Space) -- C1 (in)	C2 (in)	C3 (in)	C4 (in)	C5 (in)
1	Ford F-250 Super Duty	-29.7	0.0	7.9	2.8	6.8	0.0
		-19.2	0.0	14.1	13.9	12.6	0.0
		-8.6	0.0	15.0	14.3	12.9	0.0
		2.0	0.0	19.2	19.0	17.3	0.0
		12.5	0.0	9.0	7.9	8.4	0.0

Vehicle Name: Ford F-250 Super Duty

Imp No	Collision With	Elev/Dist (in)	-- Crush Depths (Excl. Free Space) -- C1 (in)	C2 (in)	C3 (in)	C4 (in)	C5 (in)
1	Ford Escape 4-Dr	-23.4	0.0	0.0	0.3	0.6	0.0
		-13.3	0.0	8.9	9.8	8.7	0.0
		-3.1	0.0	9.9	9.7	8.8	0.0
		7.1	2.4	11.1	12.6	11.5	0.0
		10.0	2.7	9.7	12.1	11.2	0.0

---------- DRIVER CONTROLS ----------

Driver Controls for: Ford Escape 4-Dr

DRIVER CONTROL TABLES (OPEN-LOOP)

Time (sec)	Steer Angle (deg)	Time (sec)	Pedal Force (lb)	Time (sec)	Throttle Position (%/100)
0.0000	0.00	0.0000	0.00	0.0000	0.00

Driver Controls for: Ford F-250 Super Duty

DRIVER CONTROL TABLES (OPEN-LOOP)

Time (sec)	Steer Angle (deg)	Time (sec)	Pedal Force (lb)	Time (sec)	Throttle Position (%/100)
0.0000	0.00	0.0000	0.00	0.0000	0.00

GENERAL ENVIRONMENT DATA

Environment Name:	
Date:	
Time:	
Ambient Temperature (Farenheit):	68.00
Ambient Pressure (in-Hg):	29.92
Air Density (lb/ft^3):	0.0752
Wind Speed (mph):	0.00
Wind Direction (deg):	0.00
Gravity Constant (in/sec^2):	386.40

3-D ENVIRONMENT TERRAIN DATA

3-D Terrain Filename:	None
Total Number of Polygons:	0
GetSurfaceInfo:	From Previous Polygon, Sorted
Minimum Terrain Elevation (ft):	0.00
Maximum Terrain Elevation (ft):	0.00

INTER-VEHICLE COLLISION DATA

	Relaxn Length (%/100)	Friction Coef	Restitn Coef
Ford Escape 4-Dr vs. Ford F-250 Super Duty	0.099	0.550	0.130

STATIC VEHICLE LOADS

Vehicle Axle Loads (lb): Empty

Ford Escape 4-Dr	
Axle 1:	2267.9
Axle 2:	1475.0
Total:	3743.0
Ford F-250 Super Duty	
Axle 1:	5091.3
Axle 2:	3393.7
Total:	8485.0

VEHICLE EVENT DATA

Event Data for Ford Escape 4-Dr:

Payload Information: (No Payloads)

Accelerometer Information: (No Accelerometers)

Collision Pulse Information: (No Collision Pulse)

Event Wheel Data, First Axle ---

Wheel Damage: (No Damaged Wheels on this axle)

Brake Temp/Adjustment Data: (Generic Brakes; No Data)

Brake Failure Data: (No Failed Brakes on this axle)

Tire Blow-outs: (No Tire Blow-outs on this axle)

Tire-Terrain Model Data:

	Right Side	Left Side
Tire-Terrain Model:	Point	Point

Tire Hydroplaning: (No Hydroplaning at this axle)

Event Wheel Data, Second Axle ---

Wheel Damage: (No Damaged Wheels on this axle)

Brake Temp/Adjustment Data: (Generic Brakes; No Data)

Brake Failure Data: (No Failed Brakes on this axle)

Tire Blow-outs: (No Tire Blow-outs on this axle)

Tire-Terrain Model Data:

	Right Side	Left Side
Tire-Terrain Model:	Point	Point

Tire Hydroplaning: (No Hydroplaning at this axle)

Event Data for Ford F-250 Super Duty:

Payload Information: (No Payloads)

Accelerometer Information: (No Accelerometers)

Collision Pulse Information: (No Collision Pulse)

Event Wheel Data, First Axle ---

Wheel Damage: (No Damaged Wheels on this axle)

Brake Temp/Adjustment Data: (Generic Brakes; No Data)

Brake Failure Data: (No Failed Brakes on this axle)

Tire Blow-outs: (No Tire Blow-outs on this axle)

Tire-Terrain Model Data:

	Right Side	Left Side
Tire-Terrain Model:	Point	Point

Tire Hydroplaning: (No Hydroplaning at this axle)

Event Wheel Data, Second Axle ---

Wheel Damage: (No Damaged Wheels on this axle)

Brake Temp/Adjustment Data: (Generic Brakes; No Data)

Brake Failure Data: (No Failed Brakes on this axle)

Tire Blow-outs: (No Tire Blow-outs on this axle)

Tire-Terrain Model Data:

	Right Side	Left Side
Tire-Terrain Model:	Point	Point

Tire Hydroplaning: (No Hydroplaning at this axle)

MESSAGES

No Messages

GENERAL PROGRAM INFORMATION

Execution Information ---

HVE Version:	HVE 2021 Version 17.00
SIMON Version:	5.40
Date of Execution:	Wed 05/08/24
Time of Execution:	17:06:54

Simulation Controls ---

Integration Method:	Fixed Runge-Kutta
Maximum Simulation Time (sec):	1.0000
Integration Timestep (sec):	0.0010
Output Interval (sec):	0.0100
Linear Term Vel (mph):	2.00
Angular Term Vel (deg/sec):	5.00

Calculation Options ---

GetSurfaceInfo:	From Previous Polygon, Sorted
Tire Model Method:	Semi-empirical, Vers. 3
Steer Degree Of Freedom:	Off
Articulation Option:	On
DyMESH Option:	On
Hydroplaning Option:	Off

DYMESH COLLISION MODEL INFORMATION

DyMESH Version No:	4
Include Environment:	Off
Force To x-y Plane:	Off
Restitution Model:	Relaxation Length
Search Option:	Set Box Size
User-assigned Box Size (in):	20.00
Smoothing Option:	Version 2
Accident History Basis:	Use Impact Force

--------- TECHNICAL REFERENCES ---------

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9. Day, T.D., 'Simulation of Tire Interaction with Curbs and Irregular Terrain,' HVE White Paper No. WP-2005-6, Engineering Dynamics Corporation, Beaverton, OR, 2005.

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with ABS,' SAE Paper No. 2002-01-0559, Society of Automotive Engineers, Warrendale, PA, 2002.

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VEHICLE DATA

General Information ---

Vehicle Name:	Ford Escape 4-Dr
Vehicle Type:	Sport-Utility
Vehicle Make:	Ford
Vehicle Model:	Escape
Vehicle Year:	2001-2011
Vehicle Body Style:	4-Door
Version No:	V 8.20 (RCS $Revision: 1.12
Number of Axles:	2
Driver Location:	Left Side
Engine Location:	Front Engine
Drive Axle(s):	Axle 1

Steady-State Handling Properties ---

Total Understeer Gradient (deg/g):	1.45
Steering Wheel Sensitivity (deg/g):	59.79
Roll Gradient (deg/g):	3.30
Roll Couple Distribution, F/R (%/100):	0.63
Weight Distribution, F/R (%/100):	0.61
Static Weight, Front Tires (lb):	2267.95
Static Weight, Rear Tires (lb):	1475.05

Sprung Mass Dimensional Data ---

Overall Length (in):	175.20
Overall Width (in):	70.10
Overall Height (in):	68.13
Ground Clearance (in):	11.98
Wheelbase (in):	103.10
CG to Front Axle (in):	40.02
CG to Back Axle (in):	-63.08
CG Height (in):	28.83
Front Overhang (in):	35.58
Rear Overhang (in):	36.52

Sprung Mass Inertial Data ---

Total Weight (lb):	3743.00
Sprung Weight (lb):	3545.01
Sprung Mass (lb-sec^2/in):	9.17
Sprg Mass Rot Inertia (lb-sec^2-in) - Roll:	5033.17
Pitch:	24756.02
Yaw:	25213.82
XZ Product:	0.00

Sprung Mass Aerodynamic Parameters ---

Surface Name:	Front
Drag Coefficient:	0.4000
Proj. Surface Area (in^2):	3892.65
Center of Pressure (in) - x:	75.60
y:	0.00
z:	0.00

Body Mesh Data ---

3-D Geometry Filename:	MPFordEscape054Dr.h3d
Number of Nodes:	1355
Number of Damaged Nodes:	0

------- Node Stiffness Data (3-Dimensional) -------

Front	Right	Back	Left	Top	Bottom

Const (lb/in^2):	14.12	3.43	8.61	3.43	8.33	8.33
Linear (lb/in^3):	5.43	3.07	3.63	3.07	1.67	1.67
Quadratic (lb/in^4):	0.00	0.00	0.00	0.00	0.00	0.00
Cubic (lb/in^5):	0.00	0.00	0.00	0.00	0.00	0.00
Conversion Factor(in):	30.00	30.00	30.00	30.00	30.00	30.00

Brake System Data ---

Brake System Type:	Hydraulic
Axle 1:	Disc Brakes
Axle 2:	Disc Brakes
Brake Pedal Ratio (psi/lb):	21.50
ABS System:	Tire Slip Algorithm
ABS Controller Location:	This Vehicle
Sample Method:	Wheel-Based
Delay Method:	Wheel-Based
Threshold Pressure (psi):	10.00
Threshold Velocity (mph):	4.00

Steering System Parameters ---

First Axle:	Steerable
Steering Gear Ratio (deg/deg):	17.10
Ackermann Steering Option:	On

	Right Side	Left Side
Caster (deg):	1.60	1.60
Inclination Angle (deg):	13.60	13.60
Steering Offset (in):	0.00	0.00
Stub Axle Length (in):	3.78	3.78
Initial Steer Axis Coord (in) - x:	40.02	40.02
y:	26.87	-26.87
z:	14.27	14.27

Second Axle: Not Steerable

Drivetrain Parameters ---

Engine Description:	3.0L V-6 5-Spd Manual
Maximum Power (HP):	200
Maximum Torque (ft-lb):	193
Transmission Forward Speeds:	5
Differential Speeds:	1

Wide-open Throttle, Speed (RPM):	500	2600	4850	6000	7600
Power (HP):	5	93	178	200	160
Torque (ft-lb):	50	188	193	175	111
Closed Throttle, Speed (RPM):	500	2600	4850	6000	7600
Power (HP):	-0	-13	-46	-71	-114
Torque (ft-lb):	-5	-27	-50	-62	-79

Transmission Type: Manual

Transmission Gear:	Rev	1st	2nd	3rd	4th	5th
Numerical Ratio:	-3.45	3.67	2.06	1.31	1.03	0.84

Differential Gear Ratio: 2.930

Electronic Stability Systems Properties ---

(No ESS Systems Installed.)

Wheel Location Information, First Axle ---

		Right Side	Left Side
Initial Wheel Coordinates (in) -	x:	40.02	40.02
	y:	30.65	-30.65
	z:	14.34	14.34

Suspension Information, First Axle ---

Suspension Type: Independent
Auxiliary Roll Stiffness (in-lb/deg): 2196.02

	Right Side	Left Side
Wheel Rate (lb/in):	274.84	274.84
Viscous Damping (lb-sec/in):	12.56	12.56
Coulomb Friction (lb):	50.00	50.00
Friction Null Band (in/sec):	5.00	5.00
Deflection to Jounce Stop (in):	-5.00	-5.00
Stop Linear Rate (lb/in):	300.00	300.00
Stop Cubic Rate (lb/in^3):	600.00	600.00
Stop Energy Ratio (%/100):	0.50	0.50
Deflection to Rebound Stop (in):	5.00	5.00
Stop Linear Rate (lb/in):	300.00	300.00
Stop Cubic Rate (lb/in^3):	600.00	600.00
Stop Energy Ratio (%/100):	0.50	0.50
Roll Steer Const. Coef (deg):	0.00	0.00
Roll Steer Linear Coef (deg/in):	0.00	0.00
Roll Steer Quadratic Coef (deg/in):	0.00	0.00
Roll Steer Cubic Coef (deg/in):	0.00	0.00

Camber and Half-track Tables

Right Side			Left Side		
Susp Defl (in)	Camber (deg)	1/2-track Change (in)	Susp Defl (in)	Camber (deg)	1/2-track Change (in)
-5.00	-1.00	0.00	-5.00	-1.00	0.00
0.00	-1.00	0.00	0.00	-1.00	0.00
5.00	-1.00	0.00	5.00	-1.00	0.00

Tire Information, First Axle ---

	Right Side	Left Side
Tire Name:	Generic	Generic
Tire Manufacturer:	Generic	Generic
Tire Model:	Generic	Generic
Tire Size:	P235/70R16	P235/70R16
Version No:	V 5.20	V 5.20
Unloaded Radius (in):	14.49	14.49
Static Loaded Radius (in):	13.73	13.73
Nominal Width (in):	9.25	9.25
Tread Width (in):	7.40	7.40
Init. Radial Stiffness (lb/in/tire):	1500.00	1500.00
2nd Radial Stiffness (lb/in/tire):	15000.00	15000.00
Defl. @ 2nd Stiffness (in):	5.19	5.19
Max Deflection (in):	6.49	6.49

Rebound Energy Ratio (%/100):	1.00	1.00
Spin Inertia (Tire+Whl+Brk, lb-sec^2-in/	14.62	14.62
Steer Inertia (Tire+Whl+Brk, lb-sec^2-in	7.31	7.31
Weight (Tire+Whl+Brk, lb/tire):	49.50	49.50
Roll Resistance Const:	0.01	0.01
Roll Resististance Linear Coef (sec/in):	0.00	0.00
Min Fz For Skidmark (lb):	496.00	496.00
Pneumatic Trail (in):	-1.18	-1.18

Cornering Stiffness (lb/deg/tire):

	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Load No.:	1	2	3	1	2	3
Speed No. 1:	221.6	331.6	387.0	221.6	331.6	387.0

Camber Stiffness (lb/deg/tire):

	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Load No.:	1	2	3	1	2	3
Speed No. 1:	22.2	33.2	38.7	22.2	33.2	38.7

Tire Friction Table:

	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Speed No. 1, Load No.:	1	2	3	1	2	3
Peak Mu:	0.9000	0.8500	0.8000	0.9000	0.8500	0.8000
Slide Mu:	0.7500	0.6000	0.5000	0.7500	0.6000	0.5000
Slip @ Peak Mu (%/100):	0.1600	0.1600	0.1600	0.1600	0.1600	0.1600
Long. Stiffness (lb/slip):	7000.0	13000.0	18000.0	7000.0	13000.0	18000.0

Brake Information, First Axle ---

	Right Side	Left Side
Brake Assembly Type:	Generic Brake	Generic Brake
Brake Time Lag (sec):	0.0000	0.0000
Brake Time Rise (sec):	0.0000	0.0000
Pushout Pressure (psi):	0.00	0.00
Nominal Brake Torque Ratio (in-lb/psi):	21.08	21.08

ABS Parameters ---

Min Wheel Lin Vel (mph):	4.00	4.00
Min Wheel Slip (%/100):	0.0500	0.0500
Max Wheel Slip (%/100):	0.1500	0.1500
Apply Delay (sec):	0.0500	0.0500
Pri Apply Rate (psi/sec):	5000.00	5000.00
Sec Apply Rate (psi/sec):	500.00	500.00
Release Delay (sec):	0.0500	0.0500
Release Rate (psi/sec):	10000.00	10000.00

Wheel Location Information, Second Axle ---

		Right Side	Left Side
Initial Wheel Coordinates (in) -	x:	-63.08	-63.08
	y:	30.45	-30.45
	z:	14.34	14.34

Suspension Information, Second Axle ---
Suspension Type: Independent

Auxiliary Roll Stiffness (in-lb/deg): 0.00

	Right Side	Left Side
Wheel Rate (lb/in):	183.84	183.84
Viscous Damping (lb-sec/in):	8.18	8.18
Coulomb Friction (lb):	50.00	50.00
Friction Null Band (in/sec):	5.00	5.00
Deflection to Jounce Stop (in):	-5.00	-5.00
Stop Linear Rate (lb/in):	300.00	300.00
Stop Cubic Rate (lb/in^3):	600.00	600.00
Stop Energy Ratio (%/100):	0.50	0.50
Deflection to Rebound Stop (in):	5.00	5.00
Stop Linear Rate (lb/in):	300.00	300.00
Stop Cubic Rate (lb/in^3):	600.00	600.00
Stop Energy Ratio (%/100):	0.50	0.50
Roll Steer Const. Coef (deg):	0.00	0.00
Roll Steer Linear Coef (deg/in):	0.00	0.00
Roll Steer Quadratic Coef (deg/in):	0.00	0.00
Roll Steer Cubic Coef (deg/in):	0.00	0.00

Camber and Half-track Tables

Right Side			Left Side		
Susp Defl (in)	Camber (deg)	1/2-track Change (in)	Susp Defl (in)	Camber (deg)	1/2-track Change (in)
-5.00	0.20	0.00	-5.00	0.20	0.00
0.00	0.20	0.00	0.00	0.20	0.00
5.00	0.20	0.00	5.00	0.20	0.00

Tire Information, Second Axle ---

	Right Side	Left Side
Tire Name:	Generic	Generic
Tire Manufacturer:	Generic	Generic
Tire Model:	Generic	Generic
Tire Size:	P235/70R16	P235/70R16
Version No:	V 5.20	V 5.20
Unloaded Radius (in):	14.49	14.49
Static Loaded Radius (in):	14.00	14.00
Nominal Width (in):	9.25	9.25
Tread Width (in):	7.40	7.40
Init. Radial Stiffness (lb/in/tire):	1500.00	1500.00
2nd Radial Stiffness (lb/in/tire):	15000.00	15000.00
Defl. @ 2nd Stiffness (in):	5.19	5.19
Max Deflection (in):	6.49	6.49
Rebound Energy Ratio (%/100):	1.00	1.00
Spin Inertia (Tire+Whl+Brk, lb-sec^2-in/	14.62	14.62
Steer Inertia (Tire+Whl+Brk, lb-sec^2-in	7.31	7.31
Weight (Tire+Whl+Brk, lb/tire):	49.50	49.50
Roll Resistance Const:	0.01	0.01
Roll Resististance Linear Coef (sec/in):	0.00	0.00
Min Fz For Skidmark (lb):	496.00	496.00
Pneumatic Trail (in):	-1.18	-1.18

Cornering Stiffness (lb/deg/tire):	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		

Load No.:	1	2	3	1	2	3
Speed No. 1:	221.6	331.6	387.0	221.6	331.6	387.0

Camber Stiffness (lb/deg/tire):	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Load No.:	1	2	3	1	2	3
Speed No. 1:	22.2	33.2	38.7	22.2	33.2	38.7

Tire Friction Table:	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Speed No. 1, Load No.:	1	2	3	1	2	3
Peak Mu:	0.9000	0.8500	0.8000	0.9000	0.8500	0.8000
Slide Mu:	0.7500	0.6000	0.5000	0.7500	0.6000	0.5000
Slip @ Peak Mu (%/100):	0.1600	0.1600	0.1600	0.1600	0.1600	0.1600
Long. Stiffness (lb/slip):	7000.0	13000.0	18000.0	7000.0	13000.0	18000.0

Brake Information, Second Axle ---

	Right Side	Left Side
Brake Assembly Type:	Generic Brake	Generic Brake
Brake Time Lag (sec):	0.0000	0.0000
Brake Time Rise (sec):	0.0000	0.0000
Pushout Pressure (psi):	0.00	0.00
Nominal Brake Torque Ratio (in-lb/psi):	8.77	8.77
Brake Proportioning Pressure (psi):	200.00	200.00
Brake Proportioning Ratio:	0.33	0.33
ABS Parameters ---		
Min Wheel Lin Vel (mph):	4.00	4.00
Min Wheel Slip (%/100):	0.0500	0.0500
Max Wheel Slip (%/100):	0.1500	0.1500
Apply Delay (sec):	0.0500	0.0500
Pri Apply Rate (psi/sec):	5000.00	5000.00
Sec Apply Rate (psi/sec):	500.00	500.00
Release Delay (sec):	0.0500	0.0500
Release Rate (psi/sec):	10000.00	10000.00

General Information ---

Vehicle Name:	Ford F-250 Super Duty
Vehicle Type:	Pickup
Vehicle Make:	Ford
Vehicle Model:	F-250 Super Duty
Vehicle Year:	2008 - 2016
Vehicle Body Style:	XL
Version No:	V 9.00 (RCS $Revision: 1.0
Number of Axles:	2
Driver Location:	Left Side
Engine Location:	Front Engine
Drive Axle(s):	Axles 1 and 2

Steady-State Handling Properties ---

Total Understeer Gradient (deg/g):	1.89
Steering Wheel Sensitivity (deg/g):	106.98
Roll Gradient (deg/g):	3.30
Roll Couple Distribution, F/R (%/100):	0.68
Weight Distribution, F/R (%/100):	0.60
Static Weight, Front Tires (lb):	5091.26

Static Weight, Rear Tires (lb): 3393.74

Sprung Mass Dimensional Data ---

Overall Length (in):	246.00
Overall Width (in):	80.00
Overall Height (in):	81.00
Ground Clearance (in):	19.88
Wheelbase (in):	156.00
CG to Front Axle (in):	60.13
CG to Back Axle (in):	-95.87
CG Height (in):	31.86
Front Overhang (in):	38.00
Rear Overhang (in):	52.00

Sprung Mass Inertial Data ---

Total Weight (lb):	8485.00
Sprung Weight (lb):	8068.30
Sprung Mass (lb-sec^2/in):	20.88
Sprg Mass Rot Inertia (lb-sec^2-in) - Roll:	15537.71
Pitch:	84579.82
Yaw:	81906.98
XZ Product:	0.00

Sprung Mass Aerodynamic Parameters ---

Surface Name:	Bottom
Drag Coefficient:	0.0000
Proj. Surface Area (in^2):	17656.98
Center of Pressure (in) - x:	0.00
y:	0.00
z:	12.63

Body Mesh Data ---

3-D Geometry Filename:	2015-Ford-F-250.h3d
Number of Nodes:	4769
Number of Damaged Nodes:	0

Node Stiffness Data (3-Dimensional)

	Front	Right	Back	Left	Top	Bottom
Const (lb/in^2):	21.83	2.60	9.69	2.60	8.33	8.33
Linear (lb/in^3):	5.92	1.33	4.10	1.33	1.67	1.67
Quadratic (lb/in^4):	0.00	0.00	0.00	0.00	0.00	0.00
Cubic (lb/in^5):	0.00	0.00	0.00	0.00	0.00	0.00
Conversion Factor(in):	30.00	30.00	30.00	30.00	30.00	30.00

Brake System Data ---

Brake System Type:	Hydraulic
Axle 1:	Disc Brakes
Axle 2:	Disc Brakes
Brake Pedal Ratio (psi/lb):	5.41
ABS System:	Tire Slip Algorithm
ABS Controller Location:	This Vehicle
Sample Method:	Wheel-Based
Delay Method:	Wheel-Based
Threshold Pressure (psi):	10.00
Threshold Velocity (mph):	4.00

Steering System Parameters ---

First Axle:	Steerable
Steering Gear Ratio (deg/deg):	21.46
Ackermann Steering Option:	On

	Right Side	Left Side
Caster (deg):	2.80	2.80
Inclination Angle (deg):	12.30	12.30
Steering Offset (in):	4.35	4.35
Stub Axle Length (in):	7.71	7.71
Initial Steer Axis Coord (in) - x:	60.13	60.13
y:	26.79	-26.79
z:	14.86	14.86

Second Axle: Not Steerable

Drivetrain Parameters ---

Engine Description:	6.2L_V8_
Maximum Power (HP):	385
Maximum Torque (ft-lb):	405
Transmission Forward Speeds:	6
Differential Speeds:	1

Wide-open Throttle, Speed (RPM):	500	2000	4500	5500	5600
Power (HP):	5	140	347	385	384
Torque (ft-lb):	53	368	405	368	360

Closed Throttle, Speed (RPM):	500	2000	4500	5500	5600
Power (HP):	-1	-19	-99	-147	-153
Torque (ft-lb):	-13	-51	-115	-141	-143

Transmission Type: Automatic

Shift Points -	Min	Max
Engine Speed (RPM):	1520	4580
Shift Up, WOT (%/100):	0.20	0.60
Shift Down, WOT (%/100):	0.50	0.90

Transmission Gear:	Rev	1st	2nd	3rd	4th	5th	6th
Numerical Ratio:	-3.12	3.97	2.31	1.51	1.14	0.85	0.67

Differential Gear Ratio: 3.730

Electronic Stability Systems Properties ---

(No ESS Systems Installed.)

Wheel Location Information, First Axle ---

	Right Side	Left Side
Initial Wheel Coordinates (in) - x:	60.13	60.13
y:	34.50	-34.50
z:	14.83	14.83

Suspension Information, First Axle ---

Suspension Type:	Independent
Auxiliary Roll Stiffness (in-lb/deg):	8157.78

	Right Side	Left Side
Wheel Rate (lb/in):	524.10	524.10

Viscous Damping (lb-sec/in):	6.55	6.55
Coulomb Friction (lb):	50.00	50.00
Friction Null Band (in/sec):	5.00	5.00
Deflection to Jounce Stop (in):	-3.94	-3.94
Stop Linear Rate (lb/in):	300.00	300.00
Stop Cubic Rate (lb/in^3):	600.00	600.00
Stop Energy Ratio (%/100):	0.50	0.50
Deflection to Rebound Stop (in):	2.54	2.54
Stop Linear Rate (lb/in):	300.00	300.00
Stop Cubic Rate (lb/in^3):	600.00	600.00
Stop Energy Ratio (%/100):	0.50	0.50
Roll Steer Const. Coef (deg):	-0.05	0.05
Roll Steer Linear Coef (deg/in):	0.03	-0.03
Roll Steer Quadratic Coef (deg/in):	-0.00	0.00
Roll Steer Cubic Coef (deg/in):	0.00	-0.00

Camber and Half-track Tables

Right Side			Left Side		
Susp Defl (in)	Camber (deg)	1/2-track Change (in)	Susp Defl (in)	Camber (deg)	1/2-track Change (in)
-1.93	0.10	0.00	-1.93	0.10	0.00
-1.30	0.10	-0.02	-1.30	0.10	-0.02
-0.65	0.10	0.00	-0.65	0.10	0.00
0.00	0.20	0.00	0.00	0.20	0.00
0.63	0.20	0.00	0.63	0.20	0.00
1.36	0.25	0.00	1.36	0.25	0.00
2.11	0.25	0.00	2.11	0.25	0.00
2.38	0.30	-0.02	2.38	0.30	-0.02
2.46	0.35	0.00	2.46	0.35	0.00

Tire Information, First Axle ---

	Right Side	Left Side
Tire Name:	Generic P275/60R2	Generic P275/60R2
Tire Manufacturer:	Generic	Generic
Tire Model:	Generic	Generic
Tire Size:	P275/60R20	P275/60R20
Version No:	s\DB\VM	s\DB\VM
Unloaded Radius (in):	17.05	17.05
Static Loaded Radius (in):	15.35	15.35
Nominal Width (in):	10.83	10.83
Tread Width (in):	8.66	8.66
Init. Radial Stiffness (lb/in/tire):	1500.00	1500.00
2nd Radial Stiffness (lb/in/tire):	15000.00	15000.00
Defl. @ 2nd Stiffness (in):	5.04	5.04
Max Deflection (in):	6.30	6.30
Rebound Energy Ratio (%/100):	1.00	1.00
Spin Inertia (Tire+Whl+Brk, lb-sec^2-in/	26.40	26.40
Steer Inertia (Tire+Whl+Brk, lb-sec^2-in	13.19	13.19
Weight (Tire+Whl+Brk, lb/tire):	66.50	66.50
Roll Resistance Const:	0.01	0.01
Roll Resististance Linear Coef (sec/in):	0.00	0.00
Min Fz For Skidmark (lb):	496.00	496.00
Pneumatic Trail (in):	-1.17	-1.17

Cornering Stiffness (lb/deg/tire):	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0

Speeds (in/sec):	528.0			528.0		
Load No.:	1	2	3	1	2	3
Speed No. 1:	232.8	334.5	384.0	232.8	334.5	384.0

Camber Stiffness (lb/deg/tire):	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Load No.:	1	2	3	1	2	3
Speed No. 1:	23.3	33.5	38.4	23.3	33.5	38.4

Tire Friction Table:	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Speed No. 1, Load No.:	1	2	3	1	2	3
Peak Mu:	1.1500	1.1000	1.0500	1.1500	1.1000	1.0500
Slide Mu:	0.9000	0.8500	0.8000	0.9000	0.8500	0.8000
Slip @ Peak Mu (%/100):	0.1600	0.1600	0.1600	0.1600	0.1600	0.1600
Long. Stiffness (lb/slip):	7000.0	13000.0	18000.0	7000.0	13000.0	18000.0

Brake Information, First Axle ---

	Right Side	Left Side
Brake Assembly Type:	Generic Brake	Generic Brake
Brake Time Lag (sec):	0.0000	0.0000
Brake Time Rise (sec):	0.0000	0.0000
Pushout Pressure (psi):	0.00	0.00
Nominal Brake Torque Ratio (in-lb/psi):	124.42	124.42

ABS Parameters ---

Min Wheel Lin Vel (mph):	4.00	4.00
Min Wheel Slip (%/100):	0.0500	0.0500
Max Wheel Slip (%/100):	0.1500	0.1500
Apply Delay (sec):	0.0500	0.0500
Pri Apply Rate (psi/sec):	5000.00	5000.00
Sec Apply Rate (psi/sec):	500.00	500.00
Release Delay (sec):	0.0500	0.0500
Release Rate (psi/sec):	10000.00	10000.00

Wheel Location Information, Second Axle ---

	Right Side	Left Side
Initial Wheel Coordinates (in) - x:	-95.87	-95.87
y:	34.00	-34.00
z:	14.79	14.79

Suspension Information, Second Axle ---

Suspension Type:	Solid Axle
Axle+Wheels Roll/Yaw Inertia (lb-sec^2-in):	498.28
Axle Roll Ctr Ht Below CG (in):	13.05
Axle Roll Steer (deg/deg):	0.00
Lateral Spring Spacing (in):	45.00
Nominal Track Width (in):	68.00
Total (Axle+Wheels) Unsprung Weight (lb):	283.70
Auxiliary Roll Stiffness (in-lb/deg):	299.81

	Right Side	Left Side
Wheel Rate (lb/in):	392.90	392.90
Viscous Damping (lb-sec/in):	3.63	3.63

Coulomb Friction (lb):	100.00	100.00
Friction Null Band (in/sec):	5.00	5.00
Deflection to Jounce Stop (in):	-4.72	-4.72
Stop Linear Rate (lb/in):	300.00	300.00
Stop Cubic Rate (lb/in^3):	600.00	600.00
Stop Energy Ratio (%/100):	0.50	0.50
Deflection to Rebound Stop (in):	3.46	3.46
Stop Linear Rate (lb/in):	300.00	300.00
Stop Cubic Rate (lb/in^3):	600.00	600.00
Stop Energy Ratio (%/100):	0.50	0.50
Camber Constant (deg):	0.00	0.00

Tire Information, Second Axle ---

	Right Side	Left Side
Tire Name:	Generic P275/60R2	Generic P275/60R2
Tire Manufacturer:	Generic	Generic
Tire Model:	Generic	Generic
Tire Size:	P275/60R20	P275/60R20
Version No:	s\DB\VM	s\DB\VM
Unloaded Radius (in):	17.05	17.05
Static Loaded Radius (in):	15.92	15.92
Nominal Width (in):	10.83	10.83
Tread Width (in):	8.66	8.66
Init. Radial Stiffness (lb/in/tire):	1500.00	1500.00
2nd Radial Stiffness (lb/in/tire):	15000.00	15000.00
Defl. @ 2nd Stiffness (in):	5.04	5.04
Max Deflection (in):	6.30	6.30
Rebound Energy Ratio (%/100):	1.00	1.00
Spin Inertia (Tire+Whl+Brk, lb-sec^2-in/	26.40	26.40
Steer Inertia (Tire+Whl+Brk, lb-sec^2-in	13.19	13.19
Weight (Tire+Whl+Brk, lb/tire):	66.50	66.50
Roll Resistance Const:	0.01	0.01
Roll Resististance Linear Coef (sec/in):	0.00	0.00
Min Fz For Skidmark (lb):	496.00	496.00
Pneumatic Trail (in):	-1.17	-1.17

Cornering Stiffness (lb/deg/tire):	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Load No.:	1	2	3	1	2	3
Speed No. 1:	232.8	334.5	384.0	232.8	334.5	384.0

Camber Stiffness (lb/deg/tire):	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Load No.:	1	2	3	1	2	3
Speed No. 1:	23.3	33.5	38.4	23.3	33.5	38.4

Tire Friction Table:	Right Side			Left Side		
Loads (lb):	992.0	1984.0	2976.0	992.0	1984.0	2976.0
Speeds (in/sec):	528.0			528.0		
Speed No. 1, Load No.:	1	2	3	1	2	3
Peak Mu:	1.1500	1.1000	1.0500	1.1500	1.1000	1.0500
Slide Mu:	0.9000	0.8500	0.8000	0.9000	0.8500	0.8000
Slip @ Peak Mu (%/100):	0.1600	0.1600	0.1600	0.1600	0.1600	0.1600
Long. Stiffness (lb/slip):	7000.0	13000.0	18000.0	7000.0	13000.0	18000.0

Brake Information, Second Axle ---

	Right Side	Left Side
Brake Assembly Type:	Generic Brake	Generic Brake
Brake Time Lag (sec):	0.0000	0.0000
Brake Time Rise (sec):	0.0000	0.0000
Pushout Pressure (psi):	0.00	0.00
Nominal Brake Torque Ratio (in-lb/psi):	67.87	67.87
ABS Parameters ---		
Min Wheel Lin Vel (mph):	4.00	4.00
Min Wheel Slip (%/100):	0.0500	0.0500
Max Wheel Slip (%/100):	0.1500	0.1500
Apply Delay (sec):	0.0500	0.0500
Pri Apply Rate (psi/sec):	5000.00	5000.00
Sec Apply Rate (psi/sec):	500.00	500.00
Release Delay (sec):	0.0500	0.0500
Release Rate (psi/sec):	10000.00	10000.00